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Predicting aberrant driving behaviour: The role of executive function

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ABSTRACT

The aim of the current study was to assess the relevance of three components of executive function: working memory, sustained attention and behavioural inhibition for explaining aberrant driving behaviour, driving errors, driving violations and crashes. A total of 107 participants (*M* age = 30.2; 62% male) with a valid driving license participated in the study. A battery of cognitive assessments were administered, including the Wechsler Digit Span Backward task, Continuous Performance Task (CPT), Go/No-go task, and the Driving Behaviour Questionnaire (DBQ). Results indicated that aberrant driving behaviour and driving errors were significantly correlated to sustained attention and behavioural inhibition. Driving violations related to behavioural inhibition. Regression indicated that behavioural inhibition significantly predicted aberrant driving behaviour, driving errors and driving violations. Gender predicted driving violations and driving errors. Number of reported crashes during the last year was related to driving errors, behavioural inhibition and driving violations. In conclusion, inhibitory control related to different aspects of driving indicating that impulsivity may underlie various aberrant driving behaviour and crashes. It is discussed that poor inhibitory control could result in aberrant driving behaviour causing conflict and leading to crashes.

1. Introduction

Globally, road traffic injuries (RTIs) have become a serious public health concern. The rate of road crashes and the intensity of its adverse consequences are increasing over the years in developing countries including Iran. An increment rate of 83.8% in RTIs was reported during 1997–2005 in Iran, at an estimated cost of 7.8% of the Gross National Product in year 2005 (Ayati, 2009; Rasouli, Nouri, Zarie, Saadat, & Rahimi-Movaghar, 2008). This cost is very much higher than the estimated average cost of RTIs (2.5%) worldwide. It is also higher than that reported for developed countries, viz, 1–2% (Elvik, 2000). Of this cost, an estimated 2.4% was spent in treatments of individuals injured in traffic-related incidents in Iran (Ayati, 2009). In Iran, the total Disability Adjusted Life Years (DALY) due to traffic injuries is reported to be over 1 million years for all ages combined (Naghavi et al., 2009).

In Iran, traffic risk prevention efforts have largely relied on improving environmental and vehicle safety, but recent efforts also emphasize behavioural measures (Zavareh, 2009; Zavareh et al., 2009).

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1.1. Driving behaviour

A strong link between driving behaviour and involvement in fatal crashes has been found in previous work (Rajalin, 1994). One approach to studying poor driving behaviour focuses on driver errors and violations (Reason, Manstead, Stradling, Baxter, & Campbell, 1990). Errors are the failure of planned actions to achieve their intended outcomes, which could result in potential safety threats to others, e.g., underestimating "the speed of an oncoming vehicle when passing". Violations could be deliberate contravention of practices which are necessary for maintaining safe vehicle operation, e.g. passing "through an intersection even though you know that the traffic light has turned yellow and may go red" (Zhao, Reimer, Mehler, D'Ambrosio, & Coughlin, 2013). A common measure used to assess driving errors and violations is the Driving Behaviour Questionnaire (DBQ). The DBQ's contribution in predicting crash involvement has been well established in different countries (De Winter & Dodou, 2010; Reason et al., 1990; Warner, Özkan, Lajunen, & Tzamalouka, 2011). Also, its role in mediating between traffic culture and crash involvement has been previously demonstrated (Özkan, Lajunen, Chliaoutakis, Parker, & Summala, 2006). That is, in each country, different kinds of aberrant driving behaviour may predict number of crashes. However, in most studies, violations are more likely than errors to relate to crashes (De Winter & Dodou, 2010). Several variables have been shown to be associated with driver behaviour, including demographic variables such as age, gender, exposure and experience (Lourens, Vissers, & Jessurun, 1999; Zhang, Yau, & Chen, 2013), and cognitive variables such as impulse control, attention, working memory and distractibility (Rizzo & Kellison, 2010; Zhang, Kaber, Rogers, Liang, & Gangakhedkar, 2014).

1.2. Age, gender and exposure

Numerous studies have demonstrated significant relationships between aberrant driving behaviour and demographic characteristics, including age, gender and exposure rate. Aberrant driving behaviour reduces with age, males commit more violations and fewer errors than females and that higher exposure rates relate to an increased propensity towards committing driving violations and errors (Lourens et al., 1999; Moradia, Motevalian, Mirkoohi, McKay, & Rahimi-Movaghar, 2012; Wickens, Toplak, & Wiesenthal, 2008). A recent meta-analysis by De Winter and Dodou (2010) further demonstrated the non-linear relationship between age and aberrant driving behaviour. For younger drivers, violations increase and errors decrease with age. For all other age groups, violations decrease with age (De Winter & Dodou, 2010).

1.3. Cognitive processing

Driving is purposeful and goal-directed and thus relies on mental processes that allow such behaviour (Mckenna, 1998; Rizzo & Kellison, 2010; Wickens et al., 2008). Certain cognitive abilities have been shown to be either directly associated with individual differences in crash involvement or related to driving behaviour and safety errors which in turn predict crashes (Bliokas, Taylor, Leung, & Deane, 2011; Sommer et al., 2008). Cognitive abilities that are particularly relevant to driving include perceptual style, perceptual speed, attentional skills, visual search, choice and complex reaction time and mental capacity (Mckenna, 1998; Shanmugaratnam, Kass, & Arruda, 2010; Sommer et al., 2008; Underwood, Chapman, Bowden, & Crundall, 2002). Further, the role of executive function required for purposeful and goal-directed behaviour such as selective attention and impulse control in determining driver's safety has been hypothesized (see Arthur, Barret, & Alexander, 1991 for review; Bliokas et al., 2011; Lidestam, Lundqvist, & Rönnberget, 2010; Mckenna, 1998; Rizzo & Kellison, 2010).

Executive function is a complex function entailed for completing tasks that require complex behaviour or involve multiple steps. It includes aspects of task completion such as planning, sequencing, organizing, inhibiting responses, thinking abstractly, monitoring the self, and reallocating mental resources. Executive function relies on a variety of cognitive processes including inhibitory control, working memory and attentional processes (Chan, Shum, Toulopoulou, & Chen, 2008) that may relate to driving in various ways.

1.3.1. Working memory

Driving is a cognitively effortful task requiring a mental capacity to organize and process a great deal of information simultaneously. Working memory is believed to be associated with many aspects of driving performance. Example includes glancing between the road and rearview mirror while maneuvering traffic flow to avoid collision (Rizzo & Kellison, 2010; Shanmugaratnam et al., 2010). Previous work has indicated that memory overload reduces driving safety, particularly in critical situations (Haigney, Taylor, & Westerman, 2000; Metz, Schömig, & Krüger, 2011). Experimental studies have revealed that concurrent tasks while driving increase deviation from the posted speed limit, slow driver's reaction to hazards and increase subjective workload (Horberry, Anderson, Regan, Triggs, & Brown, 2006). Also, correlational studies revealed a link between cognitive failure and driving errors (Roca, Lupiáñez, López-Ramón, & Castro, 2013). Cognitive failure was measured by Cognitive Failure Questionnaire (Broadbent, Cooper, FitzGerald, & Parkes, 1982) which measures minor perception, memory and motor functioning mistakes everyone may make from time to time (e.g., Do you forget where you put something like a newspaper or a book?). Drivers who reported a higher frequency of self-reported cognitive failures in everyday life also reported to experience frequent driving errors.

Shanmugaratnam et al. (2010) found a significant relationship between Delayed-match-to-sample which involves visual perception and short term memory with driving violation among both older and younger drivers. For the task of